



## Memorandum

**To:** Sean Sheldrake, U.S. EPA Region 10

**From:** Lance Peterson, RG and Stephen Dent, PhD

**Date:** June 25, 2013

**Subject:** Arkema Offshore NAPL Evaluation

This memorandum presents CDM Smith Inc.'s (CDM Smith) evaluation of the presence of non-aqueous phase liquid (NAPL) offshore of the Arkema Inc. facility in Portland, Oregon. This evaluation was conducted as a response to Legacy Site Services' (LSS) statement that, "There is no documented presence of NAPL in sediments off the Arkema site." This statement was made by LSS as part of their March 28, 2013 response to the U.S. Environmental Protection Agency's (EPA) February 11, 2013 comments on the draft *Engineering Evaluation and Cost Analysis* (EE/CA)(Integral Consulting Inc., 2012) for the Arkema Early Action site. Specifically, LSS made this statement in response to EPA's EE/CA Comment No. 40 in which the EPA indicated that source material (i.e., NAPL) is present offshore of the Arkema site.

## Methodology

In order to evaluate the presence of NAPL offshore of the Arkema site, CDM Smith considered several lines of evidence. The primary and strongest line of evidence used was visual observations of blebs, globules, dark brown oily material, or other similar terms as documented on existing sediment core logs. Secondary lines of evidence were also evaluated to determine if the data suggested the presence of NAPL. The secondary lines of evidence were evaluated to support the core log evaluation findings or provide information on the potential presence of NAPL where visual observations were lacking. The secondary lines of evidence evaluated included:

- ❑ Evaluating sheen and odor along with corresponding elevated organic vapor meter (OVM) measurements
- ❑ Screening of transition zone water (TZW) and in-river groundwater concentration data
- ❑ Evaluation of upland NAPL plumes with respect to proximity to the Willamette River

The following sections discuss evaluation of the primary and secondary lines of evidence and the findings with regard to the presence of NAPL offshore of the Arkema site.

## Evaluation of Sediment Core Logs

CDM Smith evaluated 73 sediment core logs obtained from the reports listed below:

- Phase II Stage 1 & 2 In-River Groundwater/Sediment Investigation Report (Integral Consulting Inc., 2003) - 25 Logs
- Portland Harbor RI/FS Round 2A Sediment Site Characterization Summary Reports and the Round 2B Field Summary Report (Lower Willamette Group, 2005) - 12 Sediment Core Logs Adjacent to the Arkema Facility
- Final Removal Action Area Characterization Report (Integral Consulting Inc., 2011) - 36 Logs

The sediment core logs were reviewed to determine if terms such as blebs, globules, dark brown oily material, etc., were documented indicating the likely presence of NAPL. Out of 73 sediment core logs reviewed, six cores were identified as containing terms indicating the presence of NAPL. These six sediment cores are:

- WB-6      The sediment core log noted that a “residual NAPL” was observed from 11.8 to 11.9 feet below mudline (ft bml). Note that there was no sample recovery from 11.9 to 15.9 ft bml as the sediment was very soft so NAPL presence could not be verified for this interval but a strong odor was noted at 15.9 ft bml at the top of the next sample recovered.  
  
In addition, the report text (Integral Consulting Inc., 2003) noted a positive response to the Sudan IV field screening for NAPL at -12.5 to -14.4 ft City of Portland Datum (CPD) although the report notes that this may have been due to petroleum hydrocarbons based on visual evidence.  
  
The report further indicates a residual NAPL of unknown origin was identified at -22.4 to -24.4 ft CPD and visual evidence of residual NAPL characteristic of DDT manufacturing (identified in text specifically as NAPL) was observed as a 0.1-foot band corresponding with a spike in an OVM measurement.
- WB-11      “Trace of dark brown oily material” noted at 6.5 to 7.5 ft bml. “Strong odor” accompanied by a “few black bands 1” thick” were noted from 13.5 to 14.5 ft bml.
- WB-35      “Small brown oil globules” noted from 8 to 9.3 ft bml. “Small brown oil globules” noted from 10 to 10.8 ft bml. “Few oil globules” noted from 13.2 to 13.3 ft bml. “Heavy sheen with oil globules” noted from 18 to 19 ft bml.
- WB-36      “SAND with black oily material” and “strong chemical/decaying vegetation odor” noted from 9.5 to 10 ft bml.

- WB-49      “A few small spotty brown oil globules” noted from 3 to 4 ft bml.
- C358      “Black liquid with oily odor” noted from 54 to 56 centimeters bml (1.77 to 1.83 ft bml).

Copies of the logs where the likely presence of NAPL has been identified are provided in **Attachment A**. The intervals where terms indicating the presence of NAPL were identified have been highlighted on each log for review. **Figure 1** shows the six sediment core locations where NAPL has been potentially identified based on a review of the sediment core logs.

In addition, CDM Smith provided oversight of field investigation activities that occurred in 2009 (CDM Federal Programs Corporation, 2010). The CDM Smith representative noted oil globules and heavy sheen in sediment core WB-35 from 8 to 10 ft bml, 12 to 14 ft bml, and 18 to 20 ft bml along with moderate to strong petroleum odors. Two photographs (No. 007 and No. 008) were taken of the core showing the oil globules.

## Secondary Lines of Evidence

### Sheen and Odors with Corresponding Elevated OVM Measurements

Sheens and odors along with corresponding elevated OVM readings provide further evidence of the presence of NAPL. *DNAPL Site Evaluation* (Cohen & Mercer, 1993), a dense NAPL (DNAPL) site evaluation guidance document, identifies a range of OVM readings from 100 to 1,000 parts per million (ppm) as potentially indicating the presence of NAPL. **Table 1** provides a summary of the sediment cores in which sheen, odor, and elevated OVM readings were observed.

Sheen covered sediment accompanied with odor, and elevated OVM readings were observed at core locations WB-6, WB-11, WB-36, WB-39, WB-42, C348, C351, C360-2 and C366-2. **Table 1** presents the OVM readings obtained at each core location. The highest OVM reading of 3,000 ppm was obtained at core location WB-6 where residual NAPL was also observed. OVM readings greater than 1,000 ppm, along with sheen and odor, were observed at sediment core locations WB-10, WB-11, and C351, providing strong evidence of the presence of NAPL. **Figure 1** shows the locations where sheen/odors and accompanied elevated OVM readings indicate the potential presence of NAPL through this secondary line of evidence. **Attachment B** provides the sediment core logs for these locations.

### TZW and In-River Groundwater Concentrations Screening

TZW and in-river groundwater concentration data was screened based on criteria presented in the *DNAPL Site Evaluation* (Cohen & Mercer, 1993) guidance document, which indicates that contaminant concentrations exceeding 1% solubility may infer the presence of NAPL. For this evaluation, two contaminants of concern were assessed: 4,4'-DDT and chlorobenzene. The 1% solubility criteria for 4,4'-DDT is 0.0325 micrograms per liter (µg/L), and the 1% solubility criteria for chlorobenzene is 5,000 µg/L.

TZW samples were collected as part of the Portland Harbor Remedial Investigation (RI) in an area along the shore just to the north of Dock 2 (downstream dock) and adjacent to the NAPL plume identified in the Arkema Upland RI Report (Environmental Resources Management, 2005), which is approximated to border the river's edge. Sample locations where concentrations exceeded the 1% solubility criteria for 4,4'-DDT and/or chlorobenzene are shown on **Table 2**. The contaminants 4,4'-DDT and/or chlorobenzene were detected in TZW samples at concentrations ranging from 0.84 to 2.7 µg/L and 12,000 to 30,000 µg/L, respectively. **Figure 1** shows the locations where elevated contaminant concentrations in TZW samples indicate the potential presence of NAPL through this secondary line of evidence.

Groundwater samples collected offshore of the Arkema site were collected during Phase II, Stage 1, of the Groundwater and Sediment Investigation performed by Integral Consulting Inc. in 2002 and 2003 for ATOFINA Chemicals. **Table 3** lists groundwater sample locations where 4,4'-DDT and/or chlorobenzene analytical results exceeded the 1% solubility criteria. Note that all positive results for 4,4'-DDT above the detection limit are listed as the detection limit did not drop below the 1% saturation criteria. Note also that all but three of the reported concentrations for DDT are above the solubility limit (i.e., fully saturated), and that one sample is over three orders of magnitude above saturation. Integral Consulting Inc. (2003) speculated that DDT concentrations elevated above saturation may have been high-biased "because the groundwater samples were collected using Geoprobe® temporary well screens," which could have introduced fine material. However, they do note that the exceedances of DDT solubility are collocated with samples of elevated chlorobenzene, which they indicated is a likely co-solvent interaction between DDT and chlorobenzene. **Figure 1** shows the locations where elevated contaminant concentrations in groundwater samples indicate the potential presence of NAPL through this secondary line of evidence.

### **Upland NAPL Plume Evaluation**

Evaluating the presence of NAPL in upland soil adjacent to the Willamette River provides evidence of potential sources of NAPL migrating to sediment offshore of the Arkema site. Dense non-aqueous phase liquid (DNAPL) plumes have been identified and characterized in the uplands of the Arkema site (Environmental Resources Management [ERM], 2005). DNAPL was identified by visual observation along with OVM readings that were then validated by Sudan IV Hydrophobic Dye testing. Ultimately, zones of residual DNAPL were characterized by OVM readings greater than 500 ppm, seen visually evident on soil particles, and the confirmed presence of brown or red droplets in the soil sample (referred to in the ERM report as ganglia or microglobules). Note that Cohen & Mercer (1993) identify a range of OVM readings that may infer the presence of NAPL from 100 to 1,000 ppm.

Two major DNAPL plumes were identified in the uplands of the Arkema site. One plume was identified beneath the former Manufacturing Process Residue (MPR) Pond and Trench, and another plume was identified just upstream of Dock 2 bordering the edge of the river bank (see ERM figure in **Attachment C**). Cross sections generated from borehole logs show a gravitational



pathway along a sloped silt layer for the NAPL to travel in a north/northeasterly direction from the former pond area toward the river.

## Evaluation Findings

Evidence for the presence of NAPL, both through direct physical and supporting ancillary (i.e., secondary) evidence, has been documented within the in-water sediments adjacent to the Arkema site. NAPL has been documented through direct visual evidence in six sediment core logs where terms such as NAPL, black oily material, black bands, and oil globules were used to describe this material. Most notably, in the Phase II sediment investigation, it was noted that the observed NAPL was “characteristic of DDT manufacturing process residue” (Integral Consulting Inc., 2003). Also, while many observations made in borehole cores are from a single discrete depth, oily globules observed in WB-35 were noted repeatedly from a depth of 8 to 19 ft bml, indicating a vertical distribution of the NAPL plume of 11 feet.

In support of the visual evidence documented for the presence of NAPL, there are multiple lines of ancillary evidence from the sediment investigations. There were a total of 9 sediment core logs that documented the presence of sheen accompanied with moderate to strong odor, and OVM readings above 100 ppm, a concentration criteria outlined in Cohen & Mercer (1993) as evidence that may infer the presence of NAPL.

Groundwater concentrations of chlorobenzene and 4,4'-DDT also support the visual documentation of NAPL. Chlorobenzene concentrations greater than 1% solubility were identified in three TZW samples and seven borehole groundwater samples. Elevated chlorobenzene results from the 2003 Phase II sediment investigation were described as being the result of, “DNAPL fluids likely migrated along more permeable sand beds within the finer-grained and less permeable sediments that slope to the southeast and generally emulated the slope of the basalt surface in the near shore area” (Integral, 2003). 4,4'-DDT concentrations greater than 1% solubility were identified in four TZW samples and 14 borehole groundwater samples, 11 of which were above 100% solubility concentrations.

Based on the primary line of evidence (visual observation), and secondary lines of evidence (sheen/odor with accompanying elevated OVM readings and elevated TZW and groundwater contaminant concentrations in excess of 1% solubility), NAPL appears to be present in the in-water sediment adjacent to the Arkema site. **Figure 1** identifies the locations with primary evidence of NAPL (i.e., visual indications) and locations with secondary evidence of NAPL (i.e., sheen/odor with accompanying elevated OVM readings and elevated TZW and groundwater contaminant concentrations in excess of 1% solubility).

## References

CDM Federal Programs Corporation. 2010. Field Oversight Report for 2009 Arkema EE/CA Investigation. Prepared for U.S. Environmental Protection Agency Region 10. Contract No. EP-W-049. November 30, 2010.

Cohen, R.M., and J.W. Mercer. 1993. *DNAPL Site Evaluation*. C.K. Smoley and CRC Press, Boca Raton, Florida.

Environmental Resources Management (ERM). 2005. Upland Remedial Investigation Report Lots 3 & 4 and Tract A – Revision 1. Prepared for Arkema, Inc., Portland, Oregon.

Integral Consulting Inc. 2003. Phase II Stage 1 & 2 In-River Groundwater and Sediment Investigation Report: Volume 1 – Report and Appendix A. Prepared for Atofina Chemicals Inc., Portland, Oregon.

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Integral Consulting Inc. 2011. Draft Final Remedial Investigation Report. Prepared for the Lower Willamette Group. Portland, Oregon.

Integral Consulting Inc. 2012. Draft Engineering Evaluation and Cost Analysis, Arkema Early Action. Prepared for Legacy Site Services LLC. July 26, 2012.

Lower Willamette Group (LWG). 2005a. Appendix A, Round 2A Subsurface Sediment Core Logs. In Portland Harbor RI/FS Round 2A Sediment Site Characterization Summary Report. Portland, Oregon.

Lower Willamette Group (LWG). 2005b. Appendix A, Field Core Log Sheets. In Portland Harbor RI/FS Round 2B Subsurface Sediment Field Sampling Report, Draft. Portland, Oregon. December 29, 2005.

Montgomery, J., Welkom, L. 1990. Groundwater Chemicals Desk Reference. Lewis Publishers, INC. Michigan.

Verschueren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co, New York.

**Table 1**  
**Summary of Cores that Exhibit Evidence of NAPL Based on Field Observations**  
Arkema Early Action Site

Core ID	Depth (ft bml)	Primary Line of Evidence		Secondary Line of Evidence		
		NAPL Observation	NAPL Description	Sheen with Odor	Sheen/Odor Description	OVM Reading >100 ppm <sup>1</sup>
WB-6	11.8 - 11.9	Yes	Residual NAPL	Yes	Strong odor	>3,000
WB-11	6.5 - 7.5	Yes	Trace of dark brown oily material	Yes	Weak odor	---
	13.5 - 14.5		Few black bands 1" thick		Strong odor	1,230
WB-35	8 - 9	Yes	Small brown oil globules	Yes	Weak to strong petroleum odor	---
	10 - 10.8		Small brown oil globules		Moderately strong petroleum odor	---
	13.2 - 13.3		Few oil globules		Sheen	139.5
	18 - 19		Oil globules		Black, heavy sheen, strong petroleum odor	---
WB-36	9.5 - 10	Yes	Black oily material	Yes	Light sheen, strong chemical/decaying vegetation odor	---
	16 - 18		NA		Strong chemical odor, light sheen	675
WB-39	10 - 12	No	NA	Yes	Strong chemical and decaying vegetation odor	824
WB-42	8 - 10	No	NA	Yes	Strong chemical odor	240
WB-49	3 - 4	Yes	Few small spotty brown oil globules	No	Weak odor	---
C348	1 - 5 (30 - 153 cm)	No	NA	Yes	Odor and light sheen in lenses	360
C351	1 - 2.6 (30 - 80 cm)	No	NA	Yes	Slight TPH odor/sheen	2,690
C358	1.77 - 1.83 (54 - 56 cm)	Yes	Black liquid	No	Oily odor	---
C360-2	2.3 - 5.9 (70 - 180 cm)	No	NA	Yes	Small sheen florets/moderately strong chemical odor	200
C366-2	6.6 - 9.4 (202 - 288 cm)	No	NA	Yes	Strong odor/pesticide and stain/sheen	270

Notes:

ft bml - feet below mudline

NA - not applicable, no NAPL observed

NAPL - non-aqueous phase liquid

OVM - organic vapor meter

ppm - parts per million

--- Indicates OVM reading was not obtained or was below the 100 ppm criteria

1) OVM screening level for NAPL (greater than 100 ppm) based on criteria presented in DNAPL Site Evaluation (Cohen & Mercer, 1993) guidance document.

**Table 2****Transition Zone Water Samples with Concentrations >1% Solubility for 4,4'-DDT or Chlorobenzene**

Arkema Early Action Site

<b>Sample ID</b>	<b>4,4'-DDT</b> 1% Solubility Limit = 0.0325 µg/L <sup>1</sup>	<b>Chlorobenzene</b> 1% Solubility Limit = 5,000 µg/L <sup>2</sup>
LWG2-T90-AP3D	---	12,000
LWG2-T30-AP3D	---	30,000
LPW-TZW3AP04D	---	12,000
LWG2-T30-AP2A	1.1	---
LWG2-T30-AP3A	1.8	---
LWG2-T30-AP3A-D	0.84	---
LWG2-T90-AP3A	2.7	---

Notes:

µg/L - micrograms per liter

--- Value did not exceed 1% solubility criteria

1) Based on 3.25 µg/L solubility in water from Verschueren (1983).

2) Based on 500,000 µg/L solubility in water from Montgomery &amp; Welkom (1990).

**Table 3****In-Water Groundwater Samples with Concentrations >1% Solubility for 4,4'-DDT or Chlorobenzene**

Arkema Early Action Site

<b>Location ID</b>	<b>4,4'-DDT</b> 1% Solubility Limit = 0.0325 µg/L <sup>1</sup>	<b>Chlorobenzene</b> 1% Solubility Limit = 5,000 µg/L <sup>2</sup>
WB-1	34	---
WB-2	29	---
WB-4	6.5	---
WB-5	65	---
WB-7	66	18,000
WB-8	17	---
WB-9	68	12,000
WB-10	1,900	64,000
WB-11	130	32,000
WB-13	0.49	12,000
WB-14	23	9,300
WB-18	0.51	---
WB-23	0.15	---
WB-25	3.6	16,000

Notes:

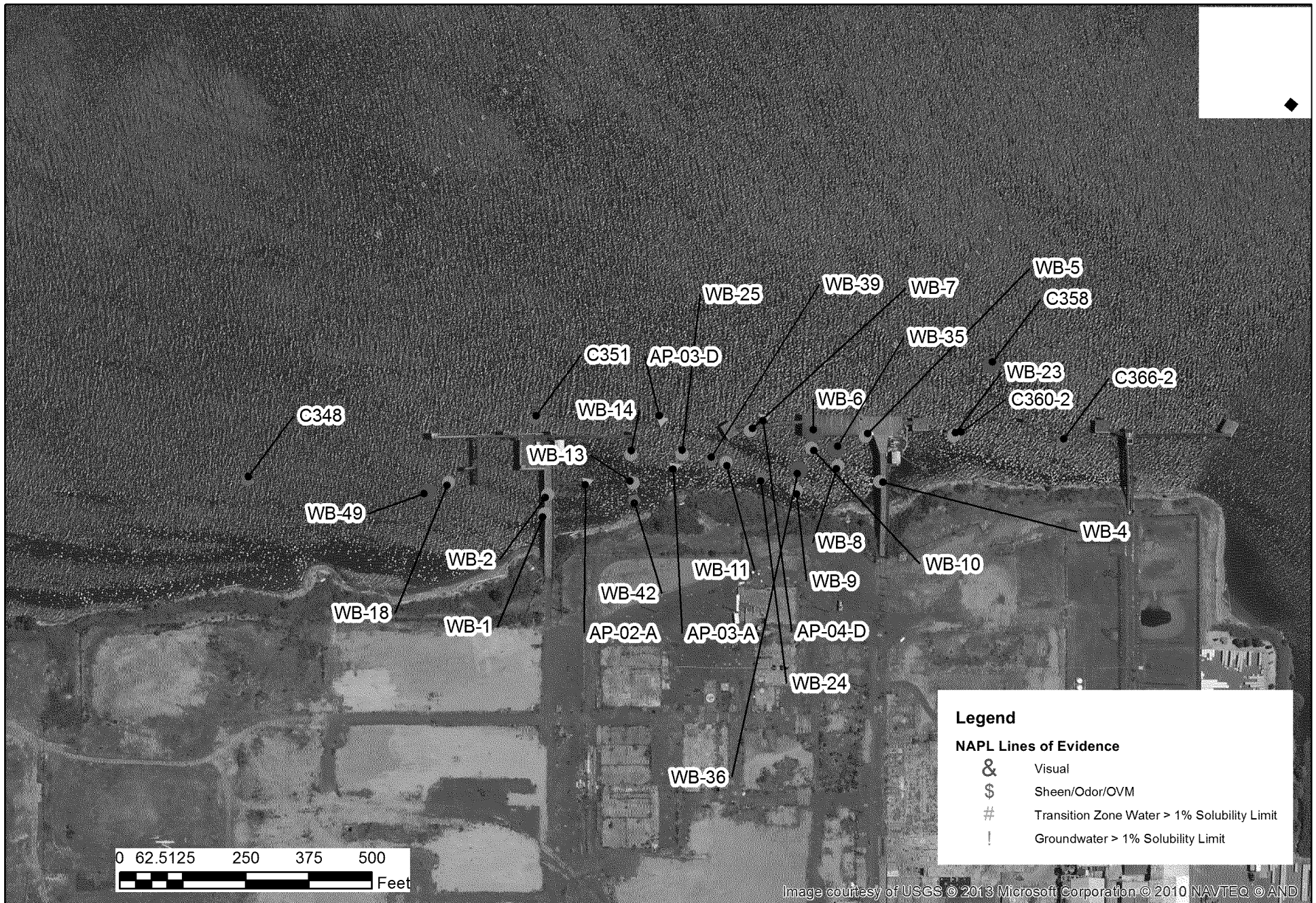
µg/L - micrograms per liter

--- Value did not exceed 1% solubility criteria

1) Based on 3.25 µg/L solubility in water from Verschueren (1983).

2) Based on 500,000 µg/L solubility in water from Montgomery &amp; Welkom (1990).

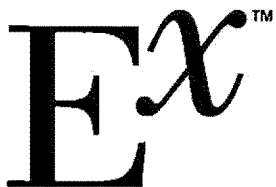
**Figure 1: Non-Aqueous Phase Liquid (NAPL) Evaluation  
Arkema Inc.  
Portland, Oregon**



**Attachment A**

**Sediment Core Logs Containing**

**Visual Evidence of NAPL**



Project No: 8601192.001.0634

Project: Acid Plant RI

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-6 (revised 9/02)

Ground surface: Dock #1

Geologist: Eron Dodak

DEPTH (Feet)	SAMPLE NUMBER	OVM (ppm)	% RECOVERY	BLOW COUNT	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	WELL CONSTRUCTION DETAIL
0							- Mudline @ 49.1' below dock	0
5								5
10								10
15								15
20								20
25								25
30								30
35								35
40								40

Drilled By: Cascade Drilling

Drill Method: Direct push probe

Drill Date: 7 June 2002

Well Casing Elevation: NA

Dock Surface Elevation: 36.56

Borehole Diameter: 2.0"

Datum: City of Portland Datum - 1929

Sheet: 1 of 2





Project No: 8601192.001.0634

Project: Acid Plant RI

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-6 (revised 9/02)

Ground surface: Dock #1

Geologist: Eron Dodak

DEPTH (Feet)	SAMPLE NUMBER	OVM (ppm)	% RECOVERY	BLOW COUNT	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	WELL CONSTRUCTION DETAIL
40								
45								
50	SO1752	7.1	100%	NA		ML	Clayey SILT, dark gray (10YR 4/1), ~15-20% clay, wet, trace (5%) tan powdery material, trace (5%) tan to light brown material, weak odor, discontinuous sheen on water. Decreased clay content below 49.5' BGS. Tan powdery material absent below 51' BGS, trace (~5-10%) non-carbonized wood, tan @ 52.5-53' BGS.	BACKFILLED w/BENTONITE GROUT
	SO1753	8.9	100%	NA			SILT, very dark gray (10YR 3/1), some very fine sandy silt zones (~25-35%), moist, weak to moderate odor.	
55	SO1754	314	30%	NA			SILT, very dark gray (2.5Y 3/1), trace very fine sand, wet, ~5-10% carbonized and non-carbonized wood, strong odor.	
60	SO1755	>3000	60%	NA		SM	Silty, very fine SAND, gray (2.5Y 5/1), ~10-20% silt, strong odor, residual NAPL observed from 60.9-61.0 ft.	
			0%	NA			Soft probing @ 61-63'. Very soft from 63-65'. Geoprobe rods sank to 65'. No sample collected.	
65	SO1756	1389	60%	NA		ML	SILT, dark gray (7.5YR 4/1), trace fibrous organics (<5%), soft, strong odor at top of sample, weak odor elsewhere, trace fine sand. Boring terminated @ 67' BGS.	
70								
75								
80								

Drilled By: Cascade Drilling

Drill Method: Direct push probe

Drill Date: 7 June 2002

Well Casing Elevation: NA

Dock Surface Elevation: 36.56

Borehole Diameter: 2.0"

Datum: City of Portland Datum - 1929

Sheet: 2 of 2



Project No: 8601192.001 0634

Borehole: WB-11

Project: ATOFINA

Client: ATOFINA Chemicals, Inc.

Ground Surface: Barge Deck

Location: Portland, OR

Logged By: Eron Dodak

DEPTH (feet)	ELEVATION (feet)	SAMPLE NUMBER	OVM (ppm)	SUDAN IV	RECOVERY	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	BACKFILL (Bentonite grout)	DEPTH (feet)	ELEVATION (feet)
0	9							Barge Deck		0	9
								Willamette River surface.			
5										5	
10										10	
								Mudline at 11.5 ft below barge deck.			
		SO1963	4.4	Neg.	100%		ML	SILT, dark olive gray (5Y 3/2), trace fine sand and organics, soft, no odor.			
								Light tan clay-rich zones, 5-10% fibrous organics.			
15		SO1964	3.7	Neg.	100%			Occasional tan clay rich laminations, weak odor.		15	
		SO1965	14.8	Neg.	30%			As above with color dark gray (5Y 4/1), weak odor, trace of dark brown oily material.			
								As above with consolidated tan fibrous material 19.3-19.4 ft below deck.			
-10										-10	
20										20	

Drilled By: Cascade Drilling

Well Casing Elevation: NA

Datum: City of Portland Datum - 1929

Drill Method: Direct Push

Barge Deck Elevation: 9.4 ft

Drill Date March 6-7, 2003

Borehole Diameter: Varies

Sheet: 1 of 2



Project No: 8601192.001 0634

Project: ATOFINA

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-11

Ground Surface: Barge Deck

Logged By: Eron Dodak

DEPTH (feet) ELEVATION (feet)	SAMPLE NUMBER	OVM (ppm)	SUDAN IV	RECOVERY	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	BACKFILL (Bentonite grout)	DEPTH (feet) ELEVATION (feet)
	SO1966	109	Neg.	20%		ML	SILT, dark gray (10YR 4/1), trace of very fine sand and fibrous organics, slightly stiff, weak to moderate odor.		
-15	SO1967	1230	Neg.	60%			As above with 1/4" thick very fine sand rich (30-40%) zone.		-15
25	SO1968	78.5	Neg.	100%			As above with strong odor, 5-10% fibrous material, few black bands 1" thick.		25
	SO1969	12.8	Neg.	75%			Trace of Silty fine SAND at bottom of sampler, dark gray (10YR 4/1), possible sheen.		
-20	SO1970	21.4	Neg.	45%			SILT, dark gray (10YR 4/1), trace micaceous very fine sand and carbonize/noncarbonized wood, slightly stiff, weak odor.		-20
30	SO1971	13.5	Neg.	35%			As above with very fine micaceous sand (10-20%), indistinct odor.		30
						SP	Slightly silty fine SAND, dark gray (2.5Y 4/1), trace wood and red grains, indistinct odor, light organic sheen at 31.7 ft only.		
							As above with very fine to fine sand, no wood, moderate odor.		
-25						SM Rx	Silty very fine SAND, olive brown (2.5Y 4/3), micaceous, 30-40% silt, piece of wood at bottom of unit, moderate odor.		-25
35							BASALT: very dark gray (2.5Y 3/1), massive, well indurated, moderate odor.		35
							Refusal on basalt at 34.0 ft below deck.		
							Groundwater sample GW03070302 collected at 23-27 ft below deck.		
							Groundwater sample GW03070301 collected at 31-33.5 ft below deck.		
-30									-30
40									40

Drilled By: Cascade Drilling

Drill Method: Direct Push

Drill Date March 6-7, 2003

Well Casing Elevation: NA

Barge Deck Elevation: 9.4 ft

Borehole Diameter: Varies

Datum: City of Portland Datum - 1929

Sheet: 2 of 2



BORING NUMBER WB-35  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

Page 1 of 3

SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-35-0-2	1025	100 (0-2)	0.3	NS		ML Sandy SILT: very dark gray (2.5Y 3/1), softer, 20% fine sand, no odor, no sheen.	
ARK-WB-35-0-10	1310	(0-10)				SP Fine to medium SAND: black (10YR 3/1), some twigs up to 2-1/2" long, no odor, no sheen.	
ARK-WB-35-2-4	1045	100 (2-4)	1.3	NS		ML SILT: very dark gray (10YR 3/1), soft, trace of organics (roots), no odor, no sheen.  As above with 20% fine to medium sand, 5% fibrous organics and roots, black (10YR 2/1), weak chemical odor at 3.0 ft bml.  At 3.8" bml, as above with 35% fine to medium sand, moderately strong chemical odor.  As above with <5% fine sand, very dark gray (10YR 3/1).  Green paint chip ~1/2" long at 4.7 ft bml.  As above with very light spotty sheen at 5.0 ft bml.	
ARK-WB-35-4-6	1105	75 (4-6)	1.3	LS*			
ARK-WB-35-6-8	1123	50 (6-8)	1.5	NS			
ARK-WB-35-8-10	1140	75 (8-10)	2.5	SH*		As above with small brown oil globules (1/32"-1/16"), weak to moderately strong petroleum odor, trace of fibrous organic material.  As above with no fibrous organic material, moderately strong petroleum odor. No oil globules at 9.3 ft, very light spotty sheen.	
ARK-WB-35-10-12	1205	100 (10-12)	10.0	SH*		Small brown oil globules (1/32"-1/16" observed on outside of sediment only from 10-10.8 ft bml, 10-15% roots/fibrous organic material, moderately strong petroleum odor.  Very light spotty sheen observed 10-8-12.0 ft bml.  At 11.2 ft bml, 15% fine sand. Small red paint chips observed 11.2-11.5 ft bml.	
ARK-WB-35-12-14	1245	100 (12-14)	139.5	LS*		As above with no sand, no paint chips, very light spotty sheen, moderately strong petroleum odor, <2% fibrous organic material.  Few oil globules ~1/4" diameter 13.2-13.3 ft bml. No sheen below 13.5 ft bml.	
ARK-WB-35-10-20	1745	100 (10-20)				Piece of purple plastic debris ~4" diameter in drill bit at 14.0 ft bml.	
ARK-WB-35-14-16	1410	(14-16)	305.7	LS*		SILT: very dark gray (10YR 3/1), soft, trace of fibrous organic material, moderately strong chemical odor, no sheen observed on sample*.	
Drilling Contractor Drilling Method Start Time End Time						Boart Longyear Roto-sonic 1012 30-Sep-09 1818 30-Sep-09	
						Sampling Equipment/Notes 4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml). Ran 6" diameter casing at 4 ft bml. Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing. Very light spotty sheen only observed in mixing bowl.	



BORING NUMBER WB-35  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

Page 2 of 3

SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol	
					ML	As above.
ARK-WB-35-16-18	1435	70 (16-18)	141.4	LS*	16	As above with 15% fine to medium sand, black (10YR 2/1), few pieces of wood debris up to 1/4" long, moderately strong chemical odor, no sheen.  Very light spotty sheen, moderately strong petroleum odor.
ARK-WB-35-18-20	1455	100 (18-20)	12.7	HS*	18	Fine to medium SAND: black (10YR 2/1), heavy sheen with oil globules 1/32 to 1/16" diameter, strong petroleum odor.  Piece of metal debris ~2" long (sheet metal) at 18.2 ft bml, 2" diameter rock at 18.5 ft bml.
					ML	SILT: dark grayish brown (10YR 4/2), coarse, micaceous, no sheen, slight petroleum odor.
ARK-WB-35-20-23	1530	65 (20-23)	1.9	NS	20	As above, no petroleum odor, no sheen.
					22	
ARK-WB-35-23-26	1550	55 (23-26)	2.2	NS	24	As above with fine to coarse silt.  As above with mostly fine silt, no sheen, no odor, silt has "clumpy" texture (silt clumps 1/8 to 1/4" diameter).  As above.
					26	As above with coarse silt (near the grain size of fine sand), no clumpy texture, no sheen, no odor.
ARK-WB-35-26-29	1610	50 (26-29)	3.8	NS	28	Piece of sheet metal ~2" diameter at 27.8 ft bml.
						Piece of crumpled sheet metal ~ 4" diameter in drill bit at 29 ft bml.
ARK-WB-35-29-32	1630	50 (29-32)	5.0	NS		As above, no sheen, no odor.
Drilling Contractor Boart Longyear Drilling Method Roto-sonic Start Time 1012 30-Sep-09 End Time 1818 30-Sep-09						<u>Sampling Equipment/Notes</u> 4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml). Ran 6" diameter casing at 4 ft bml. Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing. Very light spotty sheen only observed in mixing bowl.



BORING NUMBER WB-35  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
					ML	As above.	
ARK-WB-35-32-35	1700	100 (32-35)	1.9	NS	32--	As above with mostly fine silt, no sheen, no odor.	
						Fine sand lamination 33.10-33.15 ft bml, black (10YR 2/1).	
					34--		
ARK-WB-35-35-35.6	1700	100 (35-36.1)	7.4	NS		As above.	
						Sandy GRAVEL: very dark gray (10YR 3/1), fine to 2" diameter subrounded to rounded gravel 10-20% fine to coarse sand, no sheen, no odor.	
--	1800	~100 (36.1-36.5)	--	NS	36--	5" long cobble (basalt) in drill bit at 36.1 ft bml. Note: silt slough in sandy gravel.	
						<b>BASALT:</b> black, vesicular (vesicles 1/16-3/8" diameter), moderately well indurated, orange staining on some surfaces and in some vesicles, no sheen, no odor.	
						Borehole terminated at 36.5 ft bml.	
					38--		
					40--		
					42--		
					44--		

Drilling Contractor  
 Drilling Method  
 Start Time  
 End Time

Boart Longyear  
 Roto-sonic  
 1012 30-Sep-09  
 1818 30-Sep-09

Sampling Equipment/Notes

4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml).  
 Ran 6" diameter casing at 4 ft bml.  
 Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing.  
 Very light spotty sheen only observed in mixing bowl.



BORING NUMBER WB-36  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

Page 1 of 3

SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-36-0-2	0920	60 (0-2)	16.6	NS	ML	Clayey SILT: very dark gray (10YR 3/1), 10% clay, soft, no sheen, slight chemical odor.  Fine to medium sand laminations ~0.05 ft thick at 1.1 and 1.3 ft bml, black (10YR 2/1), slight chemical odor.	
ARK-WB-36-2-4	0935	100 (2-4)	0.7	LS*		2--	As above with very light spotty sheen at 2 ft bml.  Color black 2.7-3.0 ft bml, moderately strong chemical odor, trace of fine organics, light spotty sheen. Coarse silt, micaceous, no clay, moderately strong chemical odor, very light spotty sheen. 2" diameter rock at 3.5 ft bml.
ARK-WB-36-4-6	0950	75 (4-6)	42.1	LS*		4--	Silt fine SAND: dk. grayish brown (10YR 4/2), very light spotty sheen, strong chemical odor, 25% silt. Piece of red brick ~2" diameter at 4.8 ft bml.  As above with fine to medium sand at 5.2 ft. Few pieces of fine subrounded gravel 5.5-5.6 ft bml.
ARK-WB-36-6-8	1002	65 (6-8)	21.4	NS	SM	6--	As above with 15% silt, very dark grayish brown (10YR 3/2), strong chemical/decaying vegetation odor, trace of fine subrounded gravel 6.9-7.1 ft bml.
ARK-WB-36-8-10	1015	60 (8-10)	55.2	LS*		8--	Fine to medium SAND: black (10YR 2/1), trace of red sand grains, strong chemical/decaying vegetation odor, no sheen.  As above with 25% fine to 3/4" diameter subrounded gravel, piece of glass ~2" long.
ARK-WB-36-10-12	1035	95 (10-12)	29.8	NS	SM	10--	Silty fine to medium SAND with black oily material, light sheen, trace of wood debris, strong chemical/decaying vegetation odor.
ARK-WB-36-0-10	1420	(0-10 ft composite)					ML
ARK-WB-35-12-14		40 (12-14)	56.6	NS	SP	12--	Fine to medium SAND: very dark gray (10YR 3/1), trace of red sand grains, weak chemical odor, no sheen.  As above with color dark gray (10YR 4/1), slight chemical odor, no sheen.
ARK-WB-35-14-16	1410	100 (14-16)	306	LS*		14--	As above with strong chemical odor.
Drilling Contractor Drilling Method Start Time End Time						Boart Longyear Roto-sonic 0915 01-Oct-09 1615 01-Oct-09	
						Sampling Equipment/Notes 4" dia. x 5 ft long split spoon (0-41.9 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (41.9-42.3 ft bml).  Ran 6" dia. casing beginning at 4 ft bml *Light sheen observed on sediment only in mixing bowl.	



BORING NUMBER WB-36  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
						SP	Sand (as above).
						ML	Clayey SILT: very dark grayish brown (10YR 3/2), soft, strong chemical odor, no sheen, 20% clay.
ARK-WB-36-16-18	1130	70	675.0	LS	16	SP	Fine to medium SAND: dark gray (10YR 4/1), trace of red sand grains, strong chemical odor, light sheen observed on sediment in mixing bowl.
		(16-18)					
ARK-WB-36-10-22	1545	(10-22 composite)					Silt laminations at 16.6-16.7 and 17.0-17.2 ft, very dark gray (10YR 3/1).
							As above.
ARK-WB-36-18-20	1145	100	342.1	NS	18	ML	SILT: very dark gray (10YR 3/1), firm, trace of fibrous organic material, moderately strong chemical/decaying vegetation odor, no sheen.
		(18-20)					Trace of orange mottling.
							As above with color black (10YR 2/1), no orange mottling, no organic material, moderately strong chemical/decaying vegetation odor.
ARK-WB-36-20-22	1205	70	139.2	NS	20		As above with a trace of fibrous organic material.
		(20-22)					
						SP	Fine to medium SAND: dark gray (10YR 4/1), trace of red sand grains, moderately strong chemical/decaying vegetation odor, no sheen.
ARK-WB-36-22-25	1220	100	164.1	NS	22	ML	SILT: black (10YR 2/1), trace of fibrous organic material and wood debris up to 3" long, weak chemical odor, no sheen.
		(22-25)					Slightly lighter color below 24 ft bml, decreased organic material content.
						SP	Fine to medium SAND: dark grayish brown (10YR 4/2), trace of red sand grains, no odor, no sheen.
ARK-WB-36-25-28	1245	100	102.8	NS	26	ML	SILT: dark gray (10YR 4/1), micaceous, coarse, trace of wood debris, no odor, no sheen.
		(25-28)					As above with fine silt, 20% clay, no wood debris, slightly plastic.
						SP	Fine to medium SAND: very dark grayish brown (10YR 3/2), trace of wood debris up to 3-1/2" long, slight chemical odor, no sheen.
ARK-WB-36-28-31	1305	80	67.7	LS*	28		
ARK-WB-85-28-31	1310	(28-31)					
Drilling Contractor Boart Longyear Drilling Method Roto-sonic Start Time 0915 01-Oct-09 End Time 1615 01-Oct-09						Sampling Equipment/Notes 4" dia. x 5 ft long split spoon (0-41.9 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (41.9-42.3 ft bml).  Ran 6" dia. casing beginning at 4 ft bml *Light sheen observed on sediment only in mixing bowl.	





BORING NUMBER WB-36  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
						SP	Silt lamination 30.0–30.1 ft bml, dark gray (10YR 3/1). As above (fine to medium sand). Silt lamination 30.5–30.6 ft bml. Light spotty sheen below 30.6 ft bml, slight chemical odor. At 31 ft bml, as above with color very dark gray (10YR 3/1), slight chemical odor, no sheen.
ARK-WB-36-31-34	1430	85 (31–34)	23.8	NS	32		
						ML	SILT: very dark grayish brown (10YR 3/2), trace of fibrous organic material, no sheen, faint chemical odor.
					34		
ARK-WB-36-34-37	1445	65 (34–37)	16.8	NS		SP	Fine to medium SAND: very dark gray (2.5YR 3/1), trace of red sand grains, slight chemical odor, no sheen. 35.0–35.1 SILT lamination, gray (2.5Y 3/1), slight chemical odor, no sheen.
					36		
							SILT: very dark grayish brown (2.5Y 3/2), trace of wood debris, slight chemical odor, no sheen. As above (fine to medium sand), slight chemical odor, no sheen.
ARK-WB-36-37-40	1505	90 (37–40)	21.0	NS	38		
						ML	SILT: dark grayish brown (10YR 4/2), coarse, micaceous, no odor, no sheen.
					40		
–	1535	50 (40–41.9)	–	NS		GW	GRAVEL: dark grayish brown (10YR 4/2), fine - 1" diameter subrounded to rounded gravel, 15% medium to coarse sand, faint odor, no sheen. As above with 3 cobbles 2-1/2" to 4" diameter, subrounded to rounded.
					42		
						Rx	BASALT: black, slightly vesicular (most vesicles <1/16" diameter), well indurated, no odor, no sheen, trace of orange staining. Borehole terminated at 42.3 ft bml.
–	1550	75 (41.9–42.3)	–	NS			
					44		

Drilling Contractor Drilling Method Start Time End Time	Boart Longyear Roto-sonic 0915 01-Oct-09 1615 01-Oct-09	<b>Sampling Equipment/Notes</b> 4" dia. x 5 ft long split spoon (0–41.9 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (41.9–42.3 ft bml).  Ran 6" dia. casing beginning at 4 ft bml *Light sheen observed on sediment only in mixing bowl.
--	--	---



BORING NUMBER WB-49  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION

ASTM SEDIMENT DESCRIPTION

Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol	
ARK-WB-49-0-2	1440	85 (0-10)	0.3	LS	ML	Clayey SILT: very dark gray (10YR 3/1), 10-20% clay, soft, weak petroleum odor, light sheen.
						As above.
ARK-WB-49-2-4	1450		0.6	LS	2--	As above with a few small (<1/16" diameter) spotty brown oil globules, trace of fibrous organic material, weak petroleum odor.
ARK-WB-49-4-6	1500		1.1	LS	4--	As above with light sheen, no oil globules (oil globules limited to 3-4 bgs).
ARK-WB-49-6-8	1510		0.6	LS	6--	SP Fine to medium SAND: black (10YR 2/1), 5-10% silt, trace of red sand grains, very light spotty sheen, moderately strong petroleum odor.
						As above with no silt.
ARK-WB-49-8-10	1520		0.5	LS	8--	As above, very light spotty sheen, moderately strong petroleum odor.
ARK-WB-49-10-12	1550	65 (10-12)	0.8	NS	10--	As above with faint petroleum odor, no sheen, few pieces of fine subrounded gravel.
ARK-WB-49-12-14	1610	65 (12-14)	1.6	NS	12--	As above with no sheen, no odor, trace of coarse sand.
ARK-WB-49-14-16	1620	90 (14-16)	2.5	NS	14--	As above.

Drilling Contractor Boart Longyear  
 Drilling Method Roto-sonic  
 Start Time 1425 09-Sep-09  
 End Time 1740 09-Sep-09

Sampling Equipment/Notes

Ran 6" casing beginning at 10 ft bml.  
 3" dia. x 12 ft. long alum. vibracore tube (0-10 ft bml); 4" dia. x 5 ft long split spoon (10-23.5); 4-7/8" dia. x 5 ft long solid core sampler (23.5-24.0 ft bml).



BORING NUMBER WB-49  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

Page 2 of 2

SAMPLE INFORMATION						Group Symbol	ASTM SEDIMENT DESCRIPTION
Sample Number	Time	% Recovery	PID (ppm)	Sheen			
					16-	SP	As above.
ARK-WB-49-16-18	1635	90 (16-18)	1.8	LS			As above, no odor, no sheen.
					18-	ML	Clayey SILT: very dark gray (10YR 3/1), soft, 20% clay, very light spotty sheen, faint petroleum odor.
ARK-WB-49-18-20	1650	50 (18-20)	2.5	NS		SP	Fine to medium SAND: very dark gray (10YR 3/1), trace of red sand grains, no odor, no sheen.
ARK-WB-49-20-22	1705	75 (20-22)	0.9	NS			As above with a few pieces of fine gravel, no sheen, no odor.
ARK-WB-49-22-23.5	1720	70 (22-23.5)	0.8	NS			As above with 10% fine to 1/2" diameter subrounded to rounded gravel. As above with color very dark grayish brown (10YR 3/2), no gravel.
					24-	ML	Clayey SILT: dark grayish brown (2.5Y 4/2), 10-20% clay, no odor, no sheen. At 23.4-23.5 ft bml, 25% subrounded gravel up to 1.5" diameter.
						Rx	BASALT: black, well indurated, massive, iron staining on some surfaces, no odor or sheen.
	1740	~100 (23.5-24)	--	NS			Borehole terminated at 24 ft bml.
					26-		
					28-		

Drilling Contractor Drilling Method Start Time End Time	Boart Longyear	Sampling Equipment/Notes Ran 6" casing beginning at 10 ft bml.  3" dia. x 12 ft. long alum. vibracore tube (0-10 ft bml); 4" dia. x 5 ft long split spoon (10-23.5); 4-7/8" dia. x 5 ft long solid core sampler (23.5-24.0 ft bml).
	Roto-sonic	
	1425 09-Sep-09	
	1740 09-Sep-09	

# SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS

Core ID: LW2-C358 pg 1 of 1

## Collected:

Date: 10/26/05

Drive Length: 125'

Time: 1229

Tide Level (CRD):

Recovery Length: 101

Mudline Depth: 38.2

Recovery Efficiency:

Vessel: R.V. Nancy Anne (MSS)

Crew: DS, DO, BJ, JH

## Processed:

Date: 10/26/05

Time: 1520

Core Length: 303

Location: FIELD LAB

Crew: JS, AR, BP, RW, SF

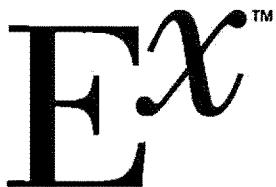
Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	FID/PID (ppm)	Sample ID
		G	S	Si/Cl			
0-30	SILT w/ SAND. SAND IS V. FINE. MED. GRAYISH BROWN. V. SOFT - SOFT. TR. METHANE VESICLES - ROOTLETS. NO. ODO.		10	90		1041/49+	LW2-C358-A (0-30) analyze layer + VOCs
30-248	SILT w/ SAND. SAND IS V. FINE - FINE. SILT AS ABOVE, w/ tr. v. fine fine sand in lenses + v. thin lam. (~1mm) soft to stiff, med. grayish brown. Trace methane vesicles. Trace rootlets. Red synthetic strands noted @ ~38cm. lens of black lignite w/ oily odor from 52-56.5cm. Mild chemical odor begins @ ~137cm and increases w/ depth. Red, pass. pt. chip @ 179cm. Faint black stain band (~1cm thick) @ 212cm. One 11 brown (beige) silt lam. (1mm) @ 196cm - med. plast. Tr. BEIGE clay lenses + lam. med.		<5	>75		714/65+	LW2-C358-B (30-152) analyze
248-303	SILT w/ SAND. AS ABOVE, SILT w/ v. fine sand and v. fine sandy thin beds - lam. med. Color change from above to a med. brown. Moderate unid. chemical odor. Stiff. Tr. rootlets + plant debris. med. plast.		<5	>75		90/55+	LW2-C358-C (152-248) analyze
						81/56+	LW2-C358-D (248-303) analyze

Core segment breaks at (cm): 0-110; 110-218; 218-303

**Attachment B**

**Sediment Core Logs Containing**

**Secondary Evidence of NAPL**



Project No: 8601192.001.0634

Project: Acid Plant RI

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-6 (revised 9/02)

Ground surface: Dock #1

Geologist: Eron Dodak

DEPTH (Feet)	SAMPLE NUMBER	OVM (ppm)	% RECOVERY	BLOW COUNT	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	WELL CONSTRUCTION DETAIL
0							- Mudline @ 49.1' below dock	0
5								5
10								10
15								15
20								20
25								25
30								30
35								35
40								40

Drilled By: Cascade Drilling

Drill Method: Direct push probe

Drill Date: 7 June 2002

Well Casing Elevation: NA

Dock Surface Elevation: 36.56

Borehole Diameter: 2.0"

Datum: City of Portland Datum - 1929

Sheet: 1 of 2



Project No: 8601192.001.0634

Project: Acid Plant RI

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-6 (revised 9/02)

Ground surface: Dock #1

Geologist: Eron Dodak

DEPTH (Feet)	SAMPLE NUMBER	OVM (ppm)	% RECOVERY	BLOW COUNT	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	WELL CONSTRUCTION DETAIL
40								
45								
50	SO1752	7.1	100%	NA		ML	Clayey SILT, dark gray (10YR 4/1), ~15-20% clay, wet, trace (5%) tan powdery material, trace (5%) tan to light brown material, weak odor, discontinuous sheen on water. Decreased clay content below 49.5' BGS. Tan powdery material absent below 51' BGS, trace (~5-10%) non-carbonized wood, tan @ 52.5-53' BGS.	BACKFILLED w/BENTONITE GROUT
	SO1753	8.9	100%	NA			SILT, very dark gray (10YR 3/1), some very fine sandy silt zones (~25-35%), moist, weak to moderate odor.	
55	SO1754	314	30%	NA			SILT, very dark gray (2.5Y 3/1), trace very fine sand, wet, ~5-10% carbonized and non-carbonized wood, strong odor.	
60	SO1755	>3000	60%	NA		SM	Silty, very fine SAND, gray (2.5Y 5/1), ~10-20% silt, strong odor, residual NAPL observed from 60.9-61.0 ft.	
			0%	NA			Soft probing @ 61-63'. Very soft from 63-65'. Geoprobe rods sank to 65'. No sample collected.	
65	SO1756	1389	60%	NA		ML	SILT, dark gray (7.5YR 4/1), trace fibrous organics (<5%), soft, strong odor at top of sample, weak odor elsewhere, trace fine sand. Boring terminated @ 67' BGS.	
70								
75								
80								

Drilled By: Cascade Drilling

Drill Method: Direct push probe

Drill Date: 7 June 2002

Well Casing Elevation: NA

Dock Surface Elevation: 36.56

Borehole Diameter: 2.0"

Datum: City of Portland Datum - 1929

Sheet: 2 of 2



Project No: 8601192.001 0634

Project: ATOFINA

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-11

Ground Surface: Barge Deck

Logged By: Eron Dodak

DEPTH (feet)	ELEVATION (feet)	SAMPLE NUMBER	OVM (ppm)	SUDAN IV	RECOVERY	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	BACKFILL (Bentonite grout)	DEPTH (feet)	ELEVATION (feet)
0	9							Barge Deck		0	9
5								Willamette River surface.		5	
10								Mudline at 11.5 ft below barge deck.		10	
		SO1963	4.4	Neg.	100%		ML	SILT, dark olive gray (5Y 3/2), trace fine sand and organics, soft, no odor.			
								Light tan clay-rich zones, 5-10% fibrous organics.			
		SO1964	3.7	Neg.	100%			Occasional tan clay rich laminations, weak odor.			
15										15	
		SO1965	14.8	Neg.	30%			As above with color dark gray (5Y 4/1), weak odor, trace of dark brown oily material.			
								As above with consolidated tan fibrous material 19.3-19.4 ft below deck.			
-10										-10	
20										20	

Drilled By: Cascade Drilling

Drill Method: Direct Push

Drill Date March 6-7, 2003

Well Casing Elevation: NA

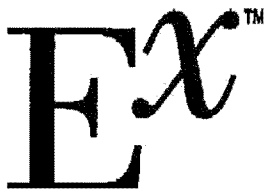
Barge Deck Elevation: 9.4 ft

Borehole Diameter: Varies

Datum: City of Portland Datum - 1929

Sheet: 1 of 2





Project No: 8601192.001 0634

Project: ATOFINA

Client: ATOFINA Chemicals, Inc.

Location: Portland, OR

Borehole: WB-11

Ground Surface: Barge Deck

Logged By: Eron Dodak

DEPTH (feet) ELEVATION (feet)	SAMPLE NUMBER	OVM (ppm)	SUDAN IV	RECOVERY	INTERVAL	GROUP SYMBOL	LITHOLOGIC DESCRIPTION	BACKFILL (Bentonite grout)	DEPTH (feet) ELEVATION (feet)
	SO1966	109	Neg.	20%		ML	SILT, dark gray (10YR 4/1), trace of very fine sand and fibrous organics, slightly stiff, weak to moderate odor.		
-15	SO1967	1230	Neg.	60%			As above with 1/4" thick very fine sand rich (30-40%) zone.		-15
25	SO1968	78.5	Neg.	100%			As above with strong odor, 5-10% fibrous material, few black bands 1" thick.		25
	SO1969	12.8	Neg.	75%			Trace of Silty fine SAND at bottom of sampler, dark gray (10YR 4/1), possible sheen.		
-20	SO1970	21.4	Neg.	45%		SP	SILT, dark gray (10YR 4/1), trace micaceous very fine sand and carbonize/noncarbonized wood, slightly stiff, weak odor.		-20
30	SO1971	13.5	Neg.	35%		SM Rx	As above with very fine micaceous sand (10-20%), indistinct odor.		30
							Slightly silty fine SAND, dark gray (2.5Y 4/1), trace wood and red grains, indistinct odor, light organic sheen at 31.7 ft only.		
-25							As above with very fine to fine sand, no wood, moderate odor.		-25
35							Silty very fine SAND, olive brown (2.5Y 4/3), micaceous, 30-40% silt, piece of wood at bottom of unit, moderate odor.		35
							BASALT: very dark gray (2.5Y 3/1), massive, well indurated, moderate odor.		
-30							Refusal on basalt at 34.0 ft below deck.		-30
40							Groundwater sample GW03070302 collected at 23-27 ft below deck.		40
							Groundwater sample GW03070301 collected at 31-33.5 ft below deck.		

Drilled By: Cascade Drilling

Drill Method: Direct Push

Drill Date March 6-7, 2003

Well Casing Elevation: NA

Barge Deck Elevation: 9.4 ft

Borehole Diameter: Varies

Datum: City of Portland Datum - 1929

Sheet: 2 of 2



BORING NUMBER WB-35  
PROJECT Arkema EE/CA  
LOCATION Portland, Oregon  
PROJECT NUMBER C167.1103  
LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-35-0-2	1025	100 (0-2)	0.3	NS		ML Sandy SILT: very dark gray (2.5Y 3/1), softer, 20% fine sand, no odor, no sheen.	
ARK-WB-35-0-10	1310	(0-10)				SP Fine to medium SAND: black (10YR 3/1), some twigs up to 2-1/2" long, no odor, no sheen.	
ARK-WB-35-2-4	1045	100 (2-4)	1.3	NS		ML SILT: very dark gray (10YR 3/1), soft, trace of organics (roots), no odor, no sheen.  As above with 20% fine to medium sand, 5% fibrous organics and roots, black (10YR 2/1), weak chemical odor at 3.0 ft bml.  At 3.8" bml, as above with 35% fine to medium sand, moderately strong chemical odor.  As above with <5% fine sand, very dark gray (10YR 3/1).  Green paint chip ~1/2" long at 4.7 ft bml.  As above with very light spotty sheen at 5.0 ft bml.	
ARK-WB-35-4-6	1105	75 (4-6)	1.3	LS*			
ARK-WB-35-6-8	1123	50 (6-8)	1.5	NS		As above with no sheen, no sand, 10-15% fibrous light brown organic material, weak chemical odor.	
ARK-WB-35-8-10	1140	75 (8-10)	2.5	SH*		As above with small brown oil globules (1/32"-1/16"), weak to moderately strong petroleum odor, trace of fibrous organic material.  As above with no fibrous organic material, moderately strong petroleum odor. No oil globules at 9.3 ft, very light spotty sheen.	
ARK-WB-35-10-12	1205	100 (10-12)	10.0	SH*		Small brown oil globules (1/32"-1/16" observed on outside of sediment only from 10-10.8 ft bml, 10-15% roots/fibrous organic material, moderately strong petroleum odor.  Very light spotty sheen observed 10-8-12.0 ft bml.  At 11.2 ft bml, 15% fine sand. Small red paint chips observed 11.2-11.5 ft bml.	
ARK-WB-35-12-14	1245	100 (12-14)	139.5	LS*		As above with no sand, no paint chips, very light spotty sheen, moderately strong petroleum odor, <2% fibrous organic material.  Few oil globules ~1/4" diameter 13.2-13.3 ft bml. No sheen below 13.5 ft bml.	
ARK-WB-35-10-20	1745	100 (10-20)				Piece of purple plastic debris ~4" diameter in drill bit at 14.0 ft bml.	
ARK-WB-35-14-16	1410	(14-16)	305.7	LS*		SILT: very dark gray (10YR 3/1), soft, trace of fibrous organic material, moderately strong chemical odor, no sheen observed on sample*.	
Drilling Contractor Boart Longyear						Sampling Equipment/Notes	
Drilling Method Roto-sonic						4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml).	
Start Time 1012 30-Sep-09						Ran 6" diameter casing at 4 ft bml.	
End Time 1818 30-Sep-09						Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing.	
						Very light spotty sheen only observed in mixing bowl.	



BORING NUMBER WB-35  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol	
					ML	As above.
ARK-WB-35-16-18	1435	70 (16-18)	141.4	LS*	16	As above with 15% fine to medium sand, black (10YR 2/1), few pieces of wood debris up to 1/4" long, moderately strong chemical odor, no sheen.  Very light spotty sheen, moderately strong petroleum odor.
ARK-WB-35-18-20	1455	100 (18-20)	12.7	HS*	18	Fine to medium SAND: black (10YR 2/1), heavy sheen with oil globules 1/32 to 1/16" diameter, strong petroleum odor.  Piece of metal debris ~2" long (sheet metal) at 18.2 ft bml, 2" diameter rock at 18.5 ft bml.
					ML	SILT: dark grayish brown (10YR 4/2), coarse, micaceous, no sheen, slight petroleum odor.
ARK-WB-35-20-23	1530	65 (20-23)	1.9	NS	20	As above, no petroleum odor, no sheen.
					22	
ARK-WB-35-23-26	1550	55 (23-26)	2.2	NS	24	As above with fine to coarse silt.  As above with mostly fine silt, no sheen, no odor, silt has "clumpy" texture (silt clumps 1/8 to 1/4" diameter).  As above.
					26	As above with coarse silt (near the grain size of fine sand), no clumpy texture, no sheen, no odor.
ARK-WB-35-26-29	1610	50 (26-29)	3.8	NS	28	Piece of sheet metal ~2" diameter at 27.8 ft bml.
						Piece of crumpled sheet metal ~ 4" diameter in drill bit at 29 ft bml.
ARK-WB-35-29-32	1630	50 (29-32)	5.0	NS		As above, no sheen, no odor.
Drilling Contractor Boart Longyear Drilling Method Roto-sonic Start Time 1012 30-Sep-09 End Time 1818 30-Sep-09						<u>Sampling Equipment/Notes</u> 4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml). Ran 6" diameter casing at 4 ft bml. Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing. Very light spotty sheen only observed in mixing bowl.



BORING NUMBER WB-35  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
					ML		As above.
ARK-WB-35-32-35	1700	100 (32-35)	1.9	NS	32--		As above with mostly fine silt, no sheen, no odor.
							Fine sand lamination 33.10-33.15 ft bml, black (10YR 2/1).
					34--		
ARK-WB-35-35-35.6	1700	100 (35-36.1)	7.4	NS			As above.
							Sandy GRAVEL: very dark gray (10YR 3/1), fine to 2" diameter subrounded to rounded gravel 10-20% fine to coarse sand, no sheen, no odor.
--	1800	~100 (36.1-36.5)	--	NS	36--	GW	5" long cobble (basalt) in drill bit at 36.1 ft bml. Note: silt slough in sandy gravel.
					--	Rx	<b>BASALT:</b> black, vesicular (vesicles 1/16-3/8" diameter), moderately well indurated, orange staining on some surfaces and in some vesicles, no sheen, no odor.
					38--		Borehole terminated at 36.5 ft bml.
					40--		
					42--		
					44--		

Drilling Contractor  
 Drilling Method  
 Start Time  
 End Time

Boart Longyear  
 Roto-sonic  
 1012 30-Sep-09  
 1818 30-Sep-09

Sampling Equipment/Notes

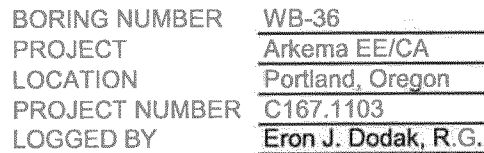
4" diameter x 5 ft long split spoon (0-36.1 ft bml); 4-7/8" diameter x 5 ft long solid core barrel (36.1-36.5 ft bml).  
 Ran 6" diameter casing at 4 ft bml.  
 Driller broke a drill rod while collecting the basalt sample (36.1-36.5 ft bml). They were able to retrieve the rod by pulling up the casing.  
 Very light spotty sheen only observed in mixing bowl.



BORING NUMBER WB-36  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-36-0-2	0920	60 (0-2)	16.6	NS	ML		Clayey SILT: very dark gray (10YR 3/1), 10% clay, soft, no sheen, slight chemical odor.
							Fine to medium sand laminations ~0.05 ft thick at 1.1 and 1.3 ft bml, black (10YR 2/1), slight chemical odor.
ARK-WB-36-2-4	0935	100 (2-4)	0.7	LS*		2--	As above with very light spotty sheen at 2 ft bml.
							Color black 2.7-3.0 ft bml, moderately strong chemical odor, trace of fine organics, light spotty sheen.
							Coarse silt, micaceous, no clay, moderately strong chemical odor, very light spotty sheen. 2" diameter rock at 3.5 ft bml.
ARK-WB-36-4-6	0950	75 (4-6)	42.1	LS*	SM	4--	Silt fine SAND: dk. grayish brown (10YR 4/2), very light spotty sheen, strong chemical odor, 25% silt.
							Piece of red brick ~2" diameter at 4.8 ft bml.
							As above with fine to medium sand at 5.2 ft.
							Few pieces of fine subrounded gravel 5.5-5.6 ft bml.
ARK-WB-36-6-8	1002	65 (6-8)	21.4	NS	SP	6--	As above with 15% silt, very dark grayish brown (10YR 3/2), strong chemical/decaying vegetation odor, trace of fine subrounded gravel 6.9-7.1 ft bml.
ARK-WB-36-8-10	1015	60 (8-10)	55.2	LS*	SM	8--	Fine to medium SAND: black (10YR 2/1), trace of red sand grains, strong chemical/decaying vegetation odor, no sheen.
							As above with 25% fine to 3/4" diameter subrounded gravel, piece of glass ~2" long.
ARK-WB-36-10-12	1035	95 (10-12)	29.8	NS	ML	10--	Silty fine to medium SAND with black oily material, light sheen, trace of wood debris, strong chemical/decaying vegetation odor.
ARK-WB-36-0-10	1420	(0-10 ft composite)			SP		Clayey SILT: black (10YR 2/1), soft, 30% clay, moderately strong chemical odor.
ARK-WB-35-12-14		40 (12-14)	56.6	NS	SP	12--	Fine to medium SAND: very dark gray (10YR 3/1), trace of red sand grains, weak chemical odor, no sheen.
							As above with color dark gray (10YR 4/1), slight chemical odor, no sheen.
ARK-WB-35-14-16	1410	100 (14-16)	306	LS*		14--	As above with strong chemical odor.
Drilling Contractor Boart Longyear Drilling Method Roto-sonic Start Time 0915 01-Oct-09 End Time 1615 01-Oct-09						<b>Sampling Equipment/Notes</b> 4" dia. x 5 ft long split spoon (0-41.9 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (41.9-42.3 ft bml).  Ran 6" dia. casing beginning at 4 ft bml *Light sheen observed on sediment only in mixing bowl.	





BORING NUMBER WB-36  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
						SP	Silt lamination 30.0–30.1 ft bml, dark gray (10YR 3/1). As above (fine to medium sand). Silt lamination 30.5–30.6 ft bml. Light spotty sheen below 30.6 ft bml, slight chemical odor. At 31 ft bml, as above with color very dark gray (10YR 3/1), slight chemical odor, no sheen.
ARK-WB-36-31-34	1430	85 (31–34)	23.8	NS	32		
						ML	SILT: very dark grayish brown (10YR 3/2), trace of fibrous organic material, no sheen, faint chemical odor.
					34		
ARK-WB-36-34-37	1445	65 (34–37)	16.8	NS		SP	Fine to medium SAND: very dark gray (2.5YR 3/1), trace of red sand grains, slight chemical odor, no sheen. 35.0–35.1 SILT lamination, gray (2.5Y 3/1), slight chemical odor, no sheen.
					36		
							SILT: very dark grayish brown (2.5Y 3/2), trace of wood debris, slight chemical odor, no sheen. As above (fine to medium sand), slight chemical odor, no sheen.
ARK-WB-36-37-40	1505	90 (37–40)	21.0	NS	38		
						ML	SILT: dark grayish brown (10YR 4/2), coarse, micaceous, no odor, no sheen.
					40		
–	1535	50 (40–41.9)	–	NS		GW	GRAVEL: dark grayish brown (10YR 4/2), fine - 1" diameter subrounded to rounded gravel, 15% medium to coarse sand, faint odor, no sheen. As above with 3 cobbles 2-1/2" to 4" diameter, subrounded to rounded.
					42		
						Rx	BASALT: black, slightly vesicular (most vesicles <1/16" diameter), well indurated, no odor, no sheen, trace of orange staining. Borehole terminated at 42.3 ft bml.
–	1550	75 (41.9–42.3)	–	NS			
					44		

Drilling Contractor	Boart Longyear	Sampling Equipment/Notes 4" dia. x 5 ft long split spoon (0–41.9 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (41.9–42.3 ft bml).  Ran 6" dia. casing beginning at 4 ft bml *Light sheen observed on sediment only in mixing bowl.
Drilling Method	Roto-sonic	
Start Time	0915 01-Oct-09	
End Time	1615 01-Oct-09	





BORING NUMBER WB-39  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-39-0-2	1525	50 (0-2)	0.4	NS		GW Sandy silty GRAVEL: very dark gray (10YR 3/1), 40% silt, 10% fine to coarse sand, fine to 3/4" angular gravel, trace of fibrous organic material (light brown), trace of glass and red brick debris up to 1/4" dia., no odor, no sheen.	
ARK-WB-39-2-4	1545	75 (2-4)	0.6	LS		ML SILT: very dark gray (10YR 3/1), 10% wood debris and fine fibrous organic material, very light spotty sheen, slight chemical odor.	
ARK-WB-39-0-8	1710	(0-8 ft composite)				Piece of rock ~4" diameter at 3.0 ft bml.	
ARK-WB-39-4-6	1606	90 (4-6)	4.0	NS		As above with color dark gray (10YR 4/1), no wood debris, trace of fine light brown fibrous organic material, abundant tan silt nodules up to 1/2" dia., no sheen, slight chemical odor, 10% clay.	
ARK-WB-39-6-8	1655	75 (6-8)	3.9	NS		As above with color very dark gray (10YR 3/1), no clay, no odor, no tan silt nodules, trace of sand.  Piece of 1/16" thick x 4" long plastic at 7.0 ft bml.  Piece of asphalt ~2-1/2" dia. At 8.0 ft bml.	
ARK-WB-39-8-10	0900	60 (8-10)	8.2	NS		As above with weak chemical odor, trace of angular gravel up to 1/2" dia.	
ARK-WB-39-8-18	1150	(8-18 ft composite)				Two pieces of concrete ~2-1/2" dia. at 9 ft bml.  Piece of concrete ~2" dia. at 10 ft bml.	
ARK-WB-39-10-12	0915	100 (10-12)	824.4	NS		As above with no gravel, strong chemical and decaying vegetation odor, dark grayish brown (10YR 4/2), some orange mottling, trace of fibrous organic material, 10% clay.	
ARK-WB-39-12-14	0935	100 (12-14)	142.3	NS		As above with no clay, very dark gray (10YR 3/1).  As above with moderately strong chemical and decaying vegetation odor, 2% wood debris 1/2"-2" long, no orange mottling.  Light brown fibrous wood debris below 13.5 ft bml.	
*Sheen observed 14-14.7 ft bml.							
ARK-WB-39-14-16	1000	100 (14-16)	14.0	LS*		SP Fine to medium SAND: black (10YR 2/1), trace of wood debris, very light spotty sheen, slight petroleum odor.	
						ML See page 2 for description.	
Drilling Contractor Boart Longyear						Sampling Equipment/Notes	
Drilling Method Roto-sonic						4" dia. x 5 ft long split spoon (0-25.7 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (25.7-26.1 ft bml).	
Start Time 1520 28-Sep-09						Ran 6" dia. casing beginning at 6 ft bml.	
End Time 1200 29-Sep-09						Barge was pivoted ~1 ft north when the borehole was sampled to 6 ft bml. There was a large rock on the sediment surface that deflected the split spoon sampler and would not allow the casing to be run through the moonpool.	





BORING NUMBER WB-39  
 PROJECT Arkema EE/CA  
 LOCATION Portland, Oregon  
 PROJECT NUMBER C167.1103  
 LOGGED BY Eron J. Dodak, R.G.


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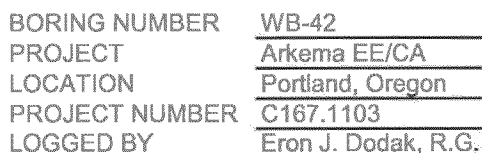
SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
					16-	ML	SILT: very dark gray (10YR 3/1), coarse, micaceous, no sheen, slight petroleum odor.
						SM	Silty fine SAND: very dark gray (10YR 3/1), 30% silt, micaceous, slight chemical odor, no sheen.
ARK-WB-39-16-18	1030	35 (16-18)	24.9	NS		SP	Fine SAND: very dark gray (10YR 3/1), 5% silt, no sheen, slight chemical odor.
ARK-WB-39-18-21	1045	100 (18-21)	14.0	LS*	18-		As above with fine to medium sand, black (10YR 2/1), no silt, trace of red sand grains, trace of wood debris 1" to 5" long, no sheen, slight chemical odor.
*Sheen 20.2-21.0 ft bml.							
					20-		Silt lamination 18.55-18.60 ft bml.
							Silt lamination 20.2-20.4 ft bml, gray (10YR 5/1), micaceous, weak chemical odor, very light spotty sheen.
ARK-WB-39-21-24	1100	100 (21-24)	18.1	LS*	22-		At 20.4 ft as above with no wood debris, weak chemical odor.
*Sheen observed 22.9-23.4 ft bml.							At 21 ft bml, as above with no sheen, slight chemical odor.
							Silt laminations ~0.05 ft thick at 21.3, 21.5, 21.7 ft.
							Silt lamination with wood debris, 22.45 to 22.65, gray (10YR 5/1).
							Silt lamination 22.9 to 23.0 ft with wood debris, light sheen, weak chemical odor.
							As above, very light spotty sheen, slight chemical odor.
ARK-WB-39-24-25.7	1130	100 (24-25.7)	8.9	NS	24-	ML	SILT: dark gray (10YR 4/1), coarse, micaceous, some orange mottling, no odor, no sheen.
							As above with color dark grayish brown (10YR 4/2), no odor, no sheen.
					26-	Rx	BASALT: black, slightly vesicular (1/16 to 1/8" dia.), well indurated, no sheen, no odor.
--	1140	~100 (25.7-26.1)	--	NS			Borehole terminated at 26.1 ft bml.
					28-		
Drilling Contractor						Sampling Equipment/Notes	
Drilling Method						4" dia. x 5 ft long split spoon (0-25.7 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (25.7-26.1 ft bml).	
Start Time						Ran 6" dia. casing beginning at 6 ft bml.	
End Time						Barge was pivoted ~1 ft north when the borehole was sampled to 6 ft bml. There was a large rock on the sediment surface that deflected the split spoon sampler and would not allow the casing to be run through the moonpool.	
Boat Longyear							
Roto-sonic							
1620 28-Sep-09							
1200 29-Sep-09							



BORING NUMBER WB-42  
PROJECT Arkema EE/CA  
LOCATION Portland, Oregon  
PROJECT NUMBER C167.1103  
LOGGED BY Eron J. Dodak, R.G.

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SAMPLE INFORMATION						ASTM SEDIMENT DESCRIPTION	
Sample Number	Time	% Recovery	PID (ppm)	Sheen	Group Symbol		
ARK-WB-42-0-2	0920	50 (0-4)	3.3	NS		GW	Sandy GRAVEL: dark brown (7.5YR 3/2), 30-40% fine to medium sand, fine to 3" diameter angular to subrounded gravel, no odor, no sheen, 5% silt.
ARK-WB-42-2-4	0930	-	1.9	NS		SW	Gravelly fine to medium SAND: black (10YR 2/1), 15-20% 3/4" to 1" diameter subrounded gravel, trace of red brick debris, slight chemical odor, no sheen.
							Sandy SILT; very dark grayish brown (10YR 3/2), micaceous, 15% fine to medium sand, trace of clear glass, slight chemical odor, no sheen.
ARK-WB-42-4-6	0945	40 (4-6)	27.3	LS			As above with 15% fine to 1.5" diameter angular gravel, trace of fibrous organic material, very light spotty sheen (1-2 spots), moderately strong chemical odor.
ARK-WB-42-0-6	1215	(0-6 ft composite)					Piece of copper wire ~4" long.
ARK-WB-42-6-8	1045	100 (6-8)	66.2	LS			SILT: very dark grayish brown (10YR 3/2), soft, <5% angular gravel up to 1.5" long, very light spotty sheen, strong chemical odor.
ARK-WB-42-8-10	1112	100 (8-10)	240.3	NS			As above with no gravel, some black mottling 8 to 8.2 ft bml, strong chemical odor.
ARK-WB-42-6-14	1450	(6-14 ft composite)					As above with 30% fine sand.
ARK-WB-42-10-12	1130	100 (10-12)	66.7	LS			As above with no sand, very light spotty sheen, strong chemical odor.
						SP	Fine to medium SAND: black (10YR 2/1), trace of coarse sand, possible very light spotty sheen, strong chemical odor.
ARK-WB-42-12-14	1150	75 (12-14)	35.9	NS		ML	SILT (as above)
					SP	Fine to medium SAND: black (10YR 2/1), trace of red sand grains, no sheen, weak chemical odor. Piece of wood debris ~2" long at 12.5 ft bml. Piece of wood debris ~1" long at 13.0 ft bml.	
ARK-WB-42-14-17	1313	75 (14-17)	9.1	NS		As above with slight chemical odor, no sheen.	
Drilling Contractor Drilling Method Start Time End Time						Boart Longyear Roto-sonic 0838 25-Sep-09 1500 25-Sep-09	
						Sampling Equipment/Notes Ran 6" dia. casing beginning at 4 ft bml. 4" dia. x 5 ft long split spoon (0-26 ft bml); 4-7/8" dia. x 5 ft long solid core barrel (26-27 ft bml).	



# SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS

Core ID: LW2-C348 pg 1 of 1

## Collected:

Date: 11/3/04 Drive Length: 14  
 Time: 1609 Tide Level (CRD):   
 Recovery Length: 12.2m Mudline Depth: 20m 13.5  
 Recovery Efficiency: 88% Vessel: R.V. Nancy Anne (MSS)  
 Crew: DB DD BT JH

## Processed:

Date: 11/9/04  
 Time: 1330  
 Core Length: 12' 2"  
 Location: CORE LAB  
 Crew: MT JM SF

Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	FID/PID (ppm)	Sample ID
		G	S	SI/CI			
0-30	SILT, gray, few fine-med grain sand, subrounded, trace wood frags small, trace rootlets, wet. no odor / sheer 90% recovery	0.15	85			7/47	LW2-C348-1 ARCHIVE
30-153	SILT, gray, trace fine grain sand, trace plant material - leaf litter to 60 cm. Lenses of some fine grain sand and few plant material @ 65-66 cm, 72-73 cm, 108-122 cm. trace wood frags. v. moist. ODOR + LIGHT SHEEN W LENSES - TPH 100% recovery	0.25	75			7/360	LW2-C348-8 ARCHIVE
153-240	SILT, gray, few fine grain sand, isolated small wood frags @ 173 cm and 240 cm. Little fine grain sand @ 157-159 cm, 173-176 cm, 209-211 cm, 229-230 cm. Black staining @ 178-179 cm, 183-184 cm, 194-195 cm, 203-204, 231-233 cm. SLIGHT TPH ODOR / STAINING WITH STAINING 1700 100% recovery	0.30	70			7/181	LW2-C348-2 ARCHIVE
240-369	SAND, fine to med grain, sub-rounded, few silt, gray 240-245 cm brown, 245-269 cm, (gradational) silt lenses @ 262-266 cm, 299-304 cm. some wood frags 240-262 cm. SLIGHT TPH ODOR / SHEEN 240-264 cm 100% recovery	0.70	30			7/161	LW2-C348-0 ARCHIVE
*ARCHIVE ALL DUE TO SPT FS minimum - 4 FT INTERVAL FOR B.							

Core segment breaks at (cm): 0-109 / 109-218 / 218-225 / 325-369

JM

# SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS

Core ID: LW2-C 351 pg 1 of 1

Collected:			Processed:		
Date: <u>4/8/04</u>	Drive Length: <u>15</u>		Date: <u>4/9/04</u>		
Time: <u>1503</u>	Tide Level (CRD): <u></u>		Time: <u>1400</u>		
Recovery Length: <u>14</u>	Mudline Depth: <u>24.8</u>		Core Length: <u>13' 1"</u>		
Recovery Efficiency: <u>93</u>	Vessel: <u>R.V. Nancy Anne (MSS)</u>		Location: <u>CORE LAB</u>		
Crew: <u>DB DO BT JH</u>			Crew: <u>MT JM SF</u>		

Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	FID/PID (ppm)	Sample ID
		G	S	Si/Cl			
0-30	0-8cm silt, gray, few fine-med grain sand, rounded well.	0.15	85			-/2200	LW2-C351-A
	8-30cm silt, gray to light gray, nothing, trace fine grain sand, nodule of string-black 27-30cm with associated TPH odor + staining.						ARCHIVE
	SLIGHT TPH + METALLIC ODOR, GREEN 80% recovery						
30-80	SILT, gray, trace fine grain sand, some water plant frags - small @ 51-80cm, wet.	0.5	95			-/2690	LW2-C351-B
	SLIGHT TPH ODOR/GREEN, W/ WOOD FRAGS 100% recovery						ANALYZE
80-212	SAND, fine to med grain, gray, moderately sorted, subrounded, trace silt, moist, isolated green silt nodule @ 150cm.	0.95	5			-/98	LW2-C351-C
	SLIGHT H <sub>2</sub> S ODOR, NO GREEN, 100% recovery						ANALYZE
212-335	SAND, AS ABOVE, transition from green to brown/gray through INTERVAL. ISOLATED SILT NODULE < 1cm @ 229cm. Few mica flakes, moist.	0.95	5			-/107	LW2-C351-D
	NO ODOR/GREEN 100% recovery						ANALYZE (FS: 8ft min)
335-399	SAND TO SILT, 335-362 SAND, trace fine grain, few silt, gray brown, few mica flakes, slightly moist.	0.65	35			-/3100	LW2-C351-E
	362-399 - SILT, brown, trace fine grain sand, isolated reddish brown nodules @ 387-395cm, moist.						ARCHIVE
	NO ODOR/GREEN 100% recovery						

Core segment breaks at (cm): 0-113 / 113-220 / 220-327 / 327-421

JM

# SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS

Core ID: LW2-C360 pg 1 of 1

Collected:			Processed:		
Date: <u>10/26/05</u>	Drive Length: <u>19'</u>		Date: <u>10/27/05</u>		
Time: <u>1459</u>	Tide Level (CRD): <u></u>		Time: <u>0915</u>		
Recovery Length: <u>17.1'</u>	Mudline Depth: <u>14.6'</u>		Core Length: <u>509</u>		
Recovery Efficiency: <u>90%</u>	Vessel: <u>R.V. Nancy Anne (MSS)</u>		Location: <u>FIELD LAB</u>		
Crew: <u>DB, AD, BJ, JH</u>			Crew: <u>NV, SP, JS, AR, MT, RW</u>		

Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	FID/ PID (ppm)	Sample ID
		G	S	Si/Cl			
0-30	Silt & sand: sand is v. fine med grayish brown, soft mud sulfur odor, to methane vesicles		10	90		31/181	LW2-C360-A2 -A3 (0-30) archive
30-70	Silt & sand: sand is v. fine med grayish brown w/ black stain banded, sulfur odor to redox + methane vesicles. ABENET color change @ ~70 cm		25	100		73/11	LW2-C360-B2 -B3 (30-70) analyze
70-509	Silt & sand: silt & sand (85/100%) w/ v. fine to fine sand w/ laminae lenses & thin beds (1cm) similar to C360-1. Fine gray laminae to orange lens, from 2mm to 5mm thick. Organics (trace) as rootlets, mostly debris (plant debris, sticks), a black stain. Trace black stain in laminae @ 300cm. Small shear clasts (1mm). Mud: strong chemical odor. Med brown, med-high plastic		25	75		30/120	LW2-C360-C2 -C3 (70-180) analyze
						45/21	LW2-C360-D2 -D3 (180-299) archive
						40/17	LW2-C360-E2 -E3 (299-421) archive
						18/10	LW2-C360-F2 -F3 (421-505) archive

Core segment breaks at (cm): 0-110; 110-214; 214-319; 319-426; 426-505



# SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS

Core ID: LW2-C366 pg 1 of 1

DUPLICATE

Collected:		Processed:	
Date: <u>11/9/04</u>	Drive Length: <u>19</u>	Date: <u>11/9/04</u>	
Time: <u>0934</u>	Tide Level (CRD): <u></u>	Time: <u>1600</u>	
Recovery Length: <u>17.2</u>	Mudline Depth: <u>13.4</u>	Core Length: <u>395</u>	
Recovery Efficiency: <u>70%</u>	Vessel: <u>R.V. Nancy Anne (MSS)</u>	Location: <u>Core Lab</u>	
Crew: <u>DB DD BJ JH</u>		Crew: <u>MT JM SF KPTD</u>	

Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	FID/PID SF (ppm)	Sample ID
		G	S	SI/CI			
0-30	SILT, Brown w red hue - staining. Few med grain sand 0-10 cm (trace sand blast grit). 22-28 cm, trace plant fibers. STRONG PESTICIDE ODOR, STAIN, 90% recovery	0.20	80			NA/103	LW2-C366-A2 ARCHIVE
30-100	SILT, Brown w red hue - staining. Few fine-med grain sand, rounded trace plant frags + wood frags. STRONG PESTICIDE ODOR/STAIN, 100% recovery	0.15	85			NA/57	LW2-C366-B2 ANALYZE
100-222	SILT, Brown w red hue staining, trace fine grain sand. Some red grain sand @ 101-103, 110-111, 127-132, 142-145, 169-172, 186-188, 195-196 cm, trace plant frags, free product @ 101-103 cm. STRONG PESTICIDE ODOR/STAIN/STAIN 100% recovery	0.20	80			NA/96	LW2-C366-C2 ANALYZE
222-288	SILT w SAND, Brown w red hue staining. Fine-med grain, silt fines @ 221-228 cm, 247-256, 263-269 cm. 278-288 cm. STRONG odor/PESTICIDE + STAIN/STAIN 100% recovery	0.35	65			NA/270	LW2-C366-D2 ANALYZE
288-348	SAND, med grain, subangular, brown. Few silt, few cobbles (rip rap) @ 320-339 cm, + silt nodules 4 cm. MODERATE PESTICIDE ODOR, 100% recovery	15	65	20		NA/214	LW2-C366-E2 ARCHIVE
348-388	SILT, LIGHT BROWN TO YELLOW, fine sand. Fine-med grain @ 360-376 cm, isolated COBBLES @ 351 cm + 374 cm. MODERATE odor PESTICIDE 100% recovery	5	80	15		NA/198	LW2-C366-F2 ANALYZE

Core segment breaks at (cm): 0-112 / 112-220 / 220-327 / 327-395

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**Attachment C**

**ERM 2005 Upland RI Report**

**Figure 8 – 3D Views of Shallow**

**Zone DNAPL**



